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ABSTRACT

The General Accounting Office recently studied automation, especially the advent of microelectronics, and its impact on unemployment. The study included identifying available information sources and obtaining opinions on the impact of automation on employment, federal efforts to predict its impact, the dissemination of information about the job outlook in the United States, and existing mechanisms for getting the displaced worker into gainful employment. The study found that automation (1) reduces the number of people required to perform the same tasks, causing displacement of people; (2) changes the nature of tasks performed by people who retain their positions; and (3) creates new occupations and increases the number of jobs in existing occupations in the same or other industries. The GAO also found that the Department of Labor forecasts there will be increased jobs despite automation, although it is impossible to measure the overall net impact. Debate arises on these predictions because of uncertainty of the rate at which new technology is going to be implemented, complexities of the issues affecting unemployment, and an absence of comprehensive data on the net change in unemployment that has occurred because of automation. The report also predicted that displacement would affect persons with high-level skills with above-average incomes, as well as those in entry-level, low-income jobs. The study concluded that little information is available about what happens to those who are displaced, and that this area should continue to be monitored. (KC)

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Preface

We performed a study of the impact of automation on employment because of concerns expressed over the issue in the United States and elsewhere. Automation, as discussed in this study, involves the use of electronic devices to reduce the amount of work performed by people. The concerns center on whether the advancement of automation will ultimately reduce the number of available jobs and increase the rate of unemployment. This study explores the views of many and presents some of the reasons for the differences of opinion that exist.

Principal sources for the information presented in this study represent a cross section of the U. S. economy: academia, trade unions, trade associations, computer manufacturers, and the Federal Government. We interviewed representatives of each of these groups and reviewed a portion of the extensive amount of literature published by some of them and by others.

The documentation obtained and used in this study was largely unverified by us. Much of it represents the opinions and study efforts of persons and institutions involved in automation and/or employment matters.

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STUDY BY THE STAFF OF THE
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ADVANCES IN AUTOMATION PROMPT CONCERN OVER INCREASED U.S. UNEMPLOYMENT

D I G E S T

The long-run impact of automation on overall unemployment is the object of considerable renewed debate. The relatively recent advent of microelectronics and other current advances in computer technology, together with automation's potential for increasing productivity and combating foreign competition, are likely to accelerate automation's use. Whether automation will increase unemployment in the long run is not known, but short-run job displacement is taking place now. Because the subject of automation is one of great concern, GAO made a study of the issues. The results are being released to make both the public and private sectors aware of the potential for job displacement caused by automation as well as the differences in opinion that exist on the subject and the reasons for those differences.

USES OF AUTOMATION HAVE JOB IMPLICATIONS

While current and proposed uses of automation can increase worker productivity and reduce unit costs, they can also have a significant impact on the size of the work force needed to produce the same or increased output. Automation has gone far beyond its earlier uses. It is being used in manufacturing, in the office, in service applications, and elsewhere. The uses are becoming more and more innovative and continue to affect jobs. (See ch. 2.) Automation

--reduces the number of people required to perform the same tasks, causing displacement of people (see pp. 5 and 13),

--changes the nature of tasks performed by people who retain their positions (see p. 15), and/or

--creates new occupations and increases the number of jobs in existing occupations in the same or other industries (see pp. 15 and 18).

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Tear Sheet

THE DEPARTMENT OF LABOR FORECASTS INCREASED JOBS DESPITE AUTOMATION

The Bureau of Labor Statistics (BLS) of the Department of Labor expects that jobs in the United States will increase by up to 31 percent between 1978 and 1990 and that the unemployment rate will be between 4 and 6 percent. (See p. 11.) It suggests that automation will cause job growth in almost as many different occupations as it will cause job loss. However, the absence of specific projections of changes due to automation makes it impossible to measure the overall net impact. (See pp. 12-16.)

REASONS FOR DIFFERENT OPINIONS ON JOB IMPACT

Although automation undoubtedly will cause some loss of jobs in the short-run, much debate arises over whether it will cause a long-run increase in unemployment overall or whether more jobs will be created because of it.

Opinions on the ultimate impact differ because of several factors, including the:

--Rate that the new technology is going to be implemented and whether institutional or other barriers to rapid implementation will exist. (See p. 19.)

--Complexities of the issues affecting unemployment. (See p. 20.)

--Absence of specific and comprehensive data on the net change in unemployment that has occurred because of automation. (See p. 21.)

These factors do leave room for disagreement on the issue. Without specific hard data, and considering the complexities of the issue, it is not surprising that different conclusions have been reached regarding the long-run impact of automation on overall unemployment.

WHO IS DISPLACED?

There is clear evidence and general agreement, however, that in the short run automation does cause job displacement. Current and future displacement could affect a large number of occupations employing persons of high level skills making better than

average incomes, as well as those in entry-level, low income jobs. Displacement also affects people entering the work force who cannot find jobs in their chosen field. (See pp. 24-26.) Examples of occupations that have been particularly hard hit include typesetters, telephone operators, and railroad employees. (See p. 14.) Future impact has been forecasted for such occupations as middle managers, teachers, inspectors, machinists, clerical workers, and assemblers. (See pp. 6, 7, and 16.)

INFORMATION ON FUTURE OF DISPLACED WORKER IS LIMITED

GAO found no recently performed comprehensive studies on what happens to the worker displaced by automation. However, a limited study in the private sector was recently made of 44 of more than 1,000 typesetters in New York City who were displaced by automation. Many of these typesetters encountered numerous personal problems in training and/or searching for new jobs. Problems included finding a job at the salary they previously earned and one that used their specialized skills. Other problems were their age and lack of mobility.

The authors of the above study concluded that government assistance--such as training, unemployment compensation, and job placement--was either inadequate, unavailable, or inappropriate and that private mechanisms were inadequate for assisting displaced typesetters. (See pp. 23 and 24.)

GAO noted other occupations that are or may be affected by automation that are similar in nature to the typesetters in terms of skills and earning capacity. But little information is available about whether those displaced find jobs of similar income and challenge. (See ch. 5.)

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Because of the potential for significant change, events in this area should continue to be watched closely by the many components of the U.S. economy (business, labor, government, and education). If a noticeable trend toward increased occupational impact occurs, existing mechanisms for assisting the unemployed may need to be reassessed. (See p. 30.)

Tear Sheet

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ABBREVIATIONS

BLS	Bureau of Labor Statistics
CETA	Comprehensive Employment and Training Act
GAO	General Accounting Office
NBS	National Bureau of Standards
NSF	National Science Foundation

CHAPTER 1

INTRODUCTION

The use of automation--electronic devices that reduce the amount of work performed by people--is currently being compared to the industrial revolution of the 19th century. The relatively recent advent of microelectronics, other advances in computer technology, other forms of electronic automation, as well as a continuing expansion of existing uses, are all likely to continue to accelerate the use of automation to perform work previously done by people.

Automation is a major and necessary tool being used to increase productivity in the United States. Increased productivity can result in more output at lower costs and can assist industries in achieving and/or maintaining a profit. It is also needed to combat foreign competition which is adversely affecting several U.S. industries. Automation used to increase productivity can have a significant impact on the work force needed to produce the same or increased output.

Automation is affecting numerous industries, occupations, services, and products. Its uses are becoming more and more innovative and its applications are becoming an integral part of manufacturing operations, office work, and services, as well as management and other decisionmaking.

Much debate has been heard over the years about the long-run impact on jobs of expanding uses of automation. The main concern is whether the replacement of people with automated devices will result in massive job reductions and unemployment. This concern has been expressed in various sectors of the economy as well as in other countries.

In chapter 2 we discuss the current and some forecasted uses of computer technology and other forms of automation, as well as the possible job implications resulting from their use. Most of the examples in that chapter and in appendix I show how automation is being applied to reduce the number of people required to perform certain tasks or functions. In some cases, the result has been displacement (unemployment). However, other information contained in this study, (ch. 3 and app. II) clearly shows that automation fosters the growth of other occupations. Automation also changes the nature of tasks performed by some people who retain their positions. Chapter 3 also presents the Department of Labor's view of future occupational demand overall.

Chapter 4 deals with the various arguments and problems involved in attempting to predict the ultimate impact this technology will have on the number of jobs available in the United States in the future. The overall impact of automation on employment in the long-run is a subject of heavy and continuing debate. The

debate and the reasons for differences of opinion are described in the chapter.

Information that is available on the workers who are displaced by automation as well as on the private and governmental mechanisms available to assist them is discussed in chapter 5. Key observations on the impact of automation on jobs are summarized in chapter 6.

OBJECTIVES, SCOPE, AND METHODOLOGY

We undertook this study of the potential impact of automation on employment because:

--In the United States and elsewhere the advent of microelectronics has created concern that the nature of the work force would change vastly, available jobs would be reduced overall, and unemployment in the long run would be increased.

--A special need exists to address the short-run issues of how to cope with and assist the worker displaced by automation even if automation had no overall net impact on the number of jobs or even if this technology created other types of jobs.

We discussed the subject of automation and employment with as many representatives of various segments of the economy as practical. We identified available sources of information and obtained opinions on (1) the impact of automation on employment and whether its advancement will be rapid, (2) Federal efforts to predict this impact and differences in opinion that exist, (3) the dissemination of information about the job outlook in the United States and data presented about the effect of automation, and (4) existing mechanisms for getting the worker, displaced by automation, into gainful employment. Our contacts are listed in appendix III and included

--several interested members of educational institutions;

--many major trade unions;

--several trade associations;

--selected major computer manufacturers;

--certain Federal agencies that have responsibilities for (1) dealing with employment matters, (2) advancing the state-of-the-art of computer technology and other forms of automation, and/or (3) providing funds for assisting educational institutions and/or the unemployed.

In addition to these contacts, we searched several available literature data bases and identified more than 1,500 documents that

addressed the subject of automation and employment. We reviewed over 100 publications in detail.

The documentation obtained and used in this study was largely unverified by us. Much of it represents the opinions and study efforts of persons and institutions involved in automation and/or employment matters.

CHAPTER 2

THE USES OF COMPUTERS AND OTHER FORMS OF AUTOMATION ARE GROWING

The use of various forms of electronic automation is increasing, involving most industries in the United States and affecting many occupations. Automation affects occupations peculiar to specific industries as well as those occupations that cross industry lines. Newer and more innovative uses of computers and other automation may become more prevalent in the not too distant future.

EXISTING AND GROWING USES OF COMPUTERS AND OTHER FORMS OF ELECTRONIC AUTOMATION CURRENTLY AFFECTING JOBS AND EMPLOYMENT

Examples of the ways that automation is currently being applied and the various industries and occupations being affected by those uses are described in the table on the next page. (Additional information on the impact of automation on 59 occupations appears in apps. I and II.)

NEWER OR PROJECTED USES OF COMPUTERS AND OTHER AUTOMATION

Members of all segments of the U.S. economy are expecting new and more innovative uses of automation in the future. Some are being tested and/or are in limited use today. The new uses of automation are, to a large degree, being made possible by the advent of microelectronics. Microelectronic computers are much smaller and more convenient and have made automation less costly and people more productive. Because of the reduced size of these computers, much more can be done. New applications will affect the employment levels of some occupations and change the nature of others.

Developed in the early 1970s, microelectronics have resulted in the widespread diffusion of new automated applications in many industries, probably with many more to come. A microelectronic silicon chip is smaller than a dime and contains thousands of electronic components and complex circuits. These chips can be combined with input, output, and memory features with appropriate software to build an entire computer system.

Microelectronics are having a significant impact on how work is being performed. Besides the wide variety of commercial products in which they are being used, microelectronic computing is now being used in industrial robots and office automation, as discussed on page 6.

Examples of Automation in Various Industries and/or Occupations

Industry (occupation)	How automation is being used
Printing and publishing (Printing compositors-typesetters	The most advanced electronic photo-typesetting equipment allows an operator, using a keyboard, to select the size and style of type as well as the column width, and to provide spacing instructions. This data, as well as the characters, are keyed and stored in a computer which displays columns of type on a cathode ray tube ("TV screen"). That way, the text can be verified and any necessary corrections made. Photography is then used for printing. Automated photographic equipment can prepare entire pages of type while previously used hand and semiautomated methods required more manual effort and prepared only single lines of type at a time.
Telephone (operators)	Traffic service position systems automatically feed data about each telephone connection into a computer. The data includes the length and cost of a call and allows billing statements to be prepared automatically. Previously, this information was tabulated by an operator who transferred it to the bill. Electronic switching systems are also being used more. They eliminate the need to manually switch telephone calls.
Insurance (Agents and brokers)	Agents and brokers are using computers to perform necessary clerical tasks such as preparing reports, maintaining records, drawing up lists of prospective customers, and planning programs tailored to the prospects' needs. In the past, much of this work was done manually.
Various (Bookkeeping workers)	Functions such as maintaining records of accounts and business transactions in journals and ledgers as well as preparing financial statements are now done more by computer than by the previous method of manually processing such data.
Railroad (Yard workers)	Freight cars are sorted in a yard with a photoelectric reading unit which is connected to a computer. When codes on the cars are read, the computer automatically switches the tracks for car sorting. This automation has eliminated the necessity for yard employees to read the freight car destination in order to assemble and disassemble trains.
Steel (Various)	Greater use is expected of computers to control plant equipment, such as in hot finishing mills and other steelmaking operations. In the automatic hot mills process, an attendant feeds instructions to the automatic equipment through a card reader. The manual operation of equipment used previously is eliminated.
Various (Credit managers)	Computers and telecommunications will enable credit-related information to be more efficiently processed, stored and, most importantly, immediately retrieved. This will slow the growth in the number of credit managers needed.
Apparel (Various)	Computers are being used to draw patterns, mark cloth for cutting, and, combined with laser technology, cut cloth. Without computers, more pattern gradercutters, markers, and machine cutters would be needed. Other automation includes sewing machines that position needles and trim threads, and devices that automatically position fabric pieces under the needle as well as remove and stack completed pieces.

Industrial robotics

The Robot Institute of America defines an industrial robot as a "reprogrammable multifunctional manipulator designed to move materials, parts, tools, or specialized devices, through variable programmed motions for the performance of a variety of tasks."

According to the Institute, about 4,000 robots are in use in U.S. manufacturing establishments, largely in automobile manufacturing plants. The robots are currently being used for spot welding, spray painting, material transfer, and die casting. They are also being programmed and used for limited assembly tasks.

The National Science Foundation (NSF) is funding some projects that could lead to more sophisticated robotic assembly operations. For instance, one project is designed to set up a robotic assembly line capable of producing small batches of different types of fractional horsepower electric motors. This project, which will help determine the general feasibility of using adaptable programmable assembly systems, could result in the manufacture of robots that can produce different sizes, configurations, and/or types of equipment, in addition to performing different functions. This project is one of the efforts that NSF has initiated to determine the feasibility of building and operating an entirely automated manufacturing plant.

The primary justification for the projects is a real need to increase the productivity of U.S. manufacturing which, in turn, should improve the competitiveness of U.S. manufactured products. According to the Department of Labor, Japan--the world leader in robot use and one of the most competitive producers of automobiles, electronic products, and other goods--has more than 12,000 robots in manufacturing plants; other estimates are higher.

Several sources have predicted that the use of robots in the United States will have its most immediate impact on automobile assemblers. These predictions have been made by, among others, the United Auto Workers. Robots are also being used currently to manufacture vacuum cleaners, sort telephone parts by color, assemble an internal aircraft part, and spray paint on refrigerator liners.

Office automation

The automation of office activity is considered a major area of current change. Office automation affects workers involved in collecting and processing data, as opposed to those acquiring and processing materials used in manufacturing. This technology, which is increasingly incorporating microelectronics, is expected to expand in the 1980s because it can reduce the cost of labor, as well as increase both the speed of processing and the office workers' productivity. Office automation reduces the amount of time consumed by clerical handling of information and more can be done

with less, without compromising quality. Office automation aides the clerical worker, for instance, by reducing the time it takes to prepare typed text. The capabilities of this automated office equipment can eliminate repetitive typing of written material, thereby improving efficiency.

Equipment currently available for clerical personnel can automatically delete, revise, or realign sentences and paragraphs. Automatic underlining, indentation, hyphenation, formatting, column breaking, and column and decimal alignment are some common features. Some equipment can search the entire text of stored material for a particular word or words and automatically make the same change to the word or words throughout. More recent equipment allows for automated correction of spelling errors and other forms of automated text editing.

Office automation can also enhance the productivity of professional and managerial staffs. For example, electronic work stations or decision support systems can give these staffs direct access to both internal and external data bases. This has been shown to improve both the efficiency and effectiveness of their decisionmaking.

Office automation equipment containing "intelligent" capabilities is being used to increase the automation of office functions, including the following.

--Automated preparation and processing of reports and documents in lieu of extensive manual rework (review, edit, and rewrite).

--Automated preparation of customized documents that contain a large percentage of constant information, such as periodic financial statements and personnel actions.

--Electronic mail, teleconferencing, and automated calendaring.

Office automation equipment is also being tied into central computer systems to allow for automatic processing of data entered into the office equipment. Further, tying systems into telecommunications allows data to be transmitted between locations.

New technology, such as voice recognition and voice output, could become an integral part of office automation in the future, thereby expanding its use.

Many experts have expressed opinions on the impact that the automation of office procedures will have on the clerical work force, which at 18 million is a large segment of the entire U.S. work force. As with other forms of automation and their applications, opinions about the future impact of automation on clerical employment vary widely. (See ch. 4.)

The impact on the professionals and managers in the office is just now beginning to be felt as large organizations begin to

develop integrated office automation systems. One large consulting firm has estimated that these systems have the potential for saving up to 15 percent of managers' and professionals' time through increases in efficiency.

Two other uses of microelectronics

Because of their small size, high levels of capacity, and processing capability, microelectronics are also being used, or planned for use, in many other applications. Two other innovative uses of microelectronics are their potential combination with videodisc technology for teaching applications and their use in evaluating the production of microelectronics themselves.

Videodisc microelectronic teaching devices 1/

In 1979, NSF awarded two contracts for the design of improved automated teaching devices by combining two relatively new technologies--microelectronics and videodisc. Courses being placed on these devices are electronics, physics, and biology.

Computer-assisted teaching technology currently exists but primarily as a combination of video tapes and large, time-shared computer systems. Current applications often lack immediate response, require scheduling for use, and often can only be accessed sequentially. Also, in current applications the tapes wear out.

The work being done under NSF contract has determined the feasibility of combining the microelectronic chips with videodiscs. The resulting systems will allow data to be instantly accessed, be highly portable and mobile, cost less (for example, discs do not wear out), and be capable of storing huge amounts of data. One videodisc can store the data contained in the entire "Encyclopedia Brittanica."

With microelectronic capability, devices will be designed to perform necessary calculations, access individual instructional frames instantly, and provide voice output along with pictures. These personalized systems will teach reading, provide feedback to the student, evaluate performance, and monitor actions. They will both show and tell what to do and how to do it.

Problems being addressed in the NSF projects include updating the data (videodiscs cannot be erased), identifying where data will be stored in the system, and reducing the high error rates currently characteristic of videodiscs.

1/A videodisc unit looks much like the phonograph; it plays discs prerecorded with television signals much as a turntable spins audio records.

Once this technology is perfected, problems will still be faced in implementing it. Among those problems are:

--A lack of skilled persons to develop the necessary software.

--Getting acceptance by potential users, primarily colleges and universities.

--A general reluctance to invest the capital needed to bring these systems into use.

Despite these problems, the development and use of these new teaching devices may eventually change teaching as we know it now. They could reduce the number of teachers required in the future and change what those remaining will do.

Microelectronics used to evaluate the chip production process

The National Bureau of Standards (NBS) acted on an industry call for a standard, automated method of measuring the quality and reliability of microelectronic chips manufactured by U.S. concerns and of diagnosing production problems. Before this call for assistance, chip quality and production process problems were determined either manually, by reviewing a sample of produced chips under a microscope, a tedious and time consuming process, or by using proprietary test chips that had no standards or criteria for comparison.

The demand for microelectronics soon exceeded the ability to produce reliable quality chips. Many recognized that this technology would be the force behind the current "electronic revolution" and was considered central to the success of industrialized societies. Since competition from Japan and Western Europe was keen, NBS, supported by the Department of Defense and other agencies, acted to improve the United States' microelectronic chip measurement capabilities.

Over a period of several years, NBS helped improve existing test chips and developed new ones, with commonly agreed upon measurement criteria. NBS also developed computer software to read the test results contained in these chips. The electronically read data obtained from the test chips are transmitted to a computer and its characteristics are measured. With these measurements the manufacturer can

--determine the overall quality of the chips being produced,

--identify manufacturing or production problems at various stages of producing the chip, and

--use the measurements to calibrate its manufacturing equipment.

The impact of this automated diagnostic technology is to eliminate the need to manually analyze manufactured chips to determine quality by making the automated approach more dependable.

Other advances can be expected--some are taking place now

Technological advances in other facets of automation are taking place now, the impact of which is not yet fully known. For instance, technological changes in telecommunications technology are underway in all major segments of the communications industry. These changes, which tie new telecommunications technology to computers, can further affect employment in the telephone industry (electronic switching), banking (electronic funds transfers), and electronic postal service functions. Other advances are occurring in the communications field--such as the expansion of satellite communications and digital transmission.

Advances in computer technology are also occurring rapidly and their applications are, or will be, expanding. Advances are being made in such areas as:

--Artificial intelligence, which is the reproduction of human problem-solving behavior, further reducing human intervention.

--Increased user-computer interaction, canned programs for small applications, and automated programming techniques, which reduce the need for programmers and other computer personnel.

--Modular design of computer hardware and other measures to reduce equipment maintenance.

--Voice recognition and voice output which may eventually reduce or eliminate some data preparation and analysis functions.

--Increased use of pattern recognition for verifying signatures and recording data from typewriters, pictures, and the like.

--Computer systems that can "see and feel."

This new technology will advance, not only because of the need to increase productivity, but also because it (1) costs less per logic function, (2) processes data faster, (3) is getting smaller, and (4) is getting less costly to maintain.

CHAPTER 3

THE DEPARTMENT OF LABOR FORECASTS INCREASED JOBS AND DISCUSSES SOME IMPACTS OF AUTOMATION

The Department of Labor's Bureau of Labor Statistics (BLS) expects that the number of jobs in the United States will increase by as much as 31 percent between 1978 and 1990. Basing its projections on an econometric model, BLS expects the number of jobs in the long run to increase both overall and for most occupations.

Although the econometric model does not contain specific data or criteria to measure the impact of automation on employment, BLS discusses its potential impact on many occupations. Comments BLS has made in documents it publishes, including the 1980-81 edition of the "Occupational Outlook Handbook," show that it expects automation to decrease jobs or slow the growth in the number of jobs in certain occupations. On the positive side, BLS also expects automation to increase the number of jobs in other occupations. In some cases, BLS believes automation will cause a shift in functions performed. BLS has not quantified the impact of automation on employment, either overall, or by occupation.

BLS PROJECTIONS SHOW OVERALL JOB INCREASES FOR MOST OCCUPATIONS

During our survey, we obtained BLS projections on the number of people BLS expects will be employed by 1990, both overall and in hundreds of occupations. Although the projections vary somewhat, each shows an overall growth--from 23 to 31 percent more than 1978 employment levels. An unemployment rate of between 4 to 6 percent is assumed.

According to BLS, projections can vary based on many factors in the economy, such as output, productivity, inflation, Government spending and tax policy, energy sources, changes in the labor force, demand for goods and services, and the gross national product. There are other factors, some of which are discussed in chapter 4.

BLS bases its projections on data collected from both employees and employers. BLS officials said that, using the econometric model, projections are factored by what is known about technological advances. BLS has a limited amount of resources for gathering data about such advances.

Information about BLS projections published in the summer of 1981 is summarized in the following schedule.

BLS Projections Show Overall Increases in Employment Levels From 1978 To 1990

	Range of BLS projection (note a)	
	Low	High
Number of occupations	b/ 340	b/ 340
Number of occupations with employment levels expected to decline	20	15
1978 employment levels (actual jobs held)	97.6 million	97.6 million
Predicted 1990 employment levels (jobs held)	119.6 million	127.9 million
Percentage increase from 1978 to 1990	23%	31%

a/The range represents different BLS projections made in the summer of 1981, each based on different assumptions concerning the growth of the labor force, output, productivity, inflation, and other factors.

b/An overall projection was made for the entire economy (all occupations), but specific projections were published only for approximately 340 occupations with employment of 25,000 or more in 1978.

Many of the individual occupations expected to decrease are those already affected heavily by automation--postal workers, printing compositors, certain textile operatives, and some railroad occupations. The projections, however, represent BLS' view that, overall, the number of available jobs in the United States will increase.

BLS EXPECTS AUTOMATION TO INCREASE JOBS IN CERTAIN OCCUPATIONS AND DECREASE THEM IN OTHERS

The occupational outlook analyses BLS performed are published in the "Occupational Outlook Handbook" and in certain other BLS publications. The primary purpose of the handbook is to provide the most comprehensive data on jobs in the United States in assisting people in making career decisions (counseling). The 1980-81 edition of the handbook discusses various aspects of and the overall outlook for 273 occupations covering 64 million jobs, or about 68 percent of total U.S. employment.

BLS does not estimate or otherwise quantify the impact of automation on employment levels in the individual occupations. It does, however, comment on how automation will affect the overall long-run growth in those occupations where it believes automation to be a factor. BLS expects automation to increase jobs in almost as many different occupations as it is likely to reduce jobs. However, the absence of specific projections makes it impossible to identify the overall net impact of automation.

Of the 273 occupations involving 64 million employees discussed in the handbook, BLS believes automation will affect 63 occupations which employ almost 15 million persons. According to the econometric model projections and the description of factors affecting each occupation, these occupations will do one of the following:

--Decline because of automation, as well as other factors.

--Grow despite the adverse impact of automation, because of other factors.

--Grow because of automation and other factors.

--Result in changes in the nature of work performed by persons employed because of automation.

Some occupations will grow more slowly or decline because of automation

According to the "Occupational Outlook Handbook," 33 occupations, which in 1978 employed about 8 million persons, will be adversely affected by automation. BLS projected that 22 of these occupations, involving 7 million jobs, are still expected to grow despite this adverse impact. The remaining 11 occupations are not expected to grow, and several will decline.

Following is a list of occupations BLS feels will be adversely affected by automation. (App. I provides more detail about the effect of automation on each.)

33 Occupations Expected to be Adversely Affected by Automation (note a)

Occupation	No growth or decline	Will grow despite automation
Boiler tenders	X	
Bookkeeping workers		X
Broadcast technicians		X
Buyers		X
Cashiers		X
Central office telephone crafts	X	
Credit managers		X
Drafters		X
Electroplaters	X	
Electrotypers and stereotypers	X	
File clerks		X
Hotel front office clerks		X
Insurance agents and brokers		X
Insurance claim representatives		X
Machine set up workers		X
Machine tool operators		X
Molders		X
Motion picture projectionists	X	
Office machine operators		X
Photoengravers	X	
Photographic laboratory occupations		X
Postal clerks	X	
Printing compositors	X	
Production painters		X
Radio and television announcers		X
Railroad brake operators	X	
Railroad conductors		X
Railroad locomotive engineers		X
Railroad telegraphers, telephoners, and tower operators	X	
Shipping and receiving clerks		X
Stock clerks		X
Telephone operators	X	
Tool-and-die makers		X

a/According to the "Occupational Outlook Handbook," 1980-81 edition.

Some occupations are growing because of automation and other factors

The "Occupational Outlook Handbook" identifies 26 occupations (see table below) employing almost 5 million persons in 1978 that are expected to grow, at least in part, because of automation. Some detail about them--for example, how automation enhances their growth--is presented in appendix II. BLS does not estimate how many additional jobs will be created as a direct result of automation.

26 Occupations Expected to Grow Because of Automation and Other Factors

Accountants	Engineering and science technicians
Bank clerks	Industrial engineers
Bank officers and managers	Instrument makers (mechanical)
Business machine repairers	Librarians
Ceramic engineers	Maintenance electricians
Chemical engineers	Mathematicians
City managers	Medical record administrators
Computer operators	Metallurgical engineers
Computer programmers	Physicists
Computer service technicians	Political scientists
Economists	Sociologists
Electrical engineers	State police
	Systems analysts
	Technical writers

Functions will change in certain occupations

Several occupations will change because of the implementation of electronic automation. Persons remaining in those occupations will be performing tasks not previously done, some of which will require new skills that can be learned. For instance, managers might be required to type, and production workers, instead of performing actual manufacturing and assembly work, will tend to automated equipment.

The "Occupational Outlook Handbook" discusses some occupational functions changed by automation. Four in particular were noted during our study of the handbook. For instance, the demand for typists is expected to increase, but many employers will prefer typists who are familiar with office automation equipment. Statistical clerks may find some routine tasks eliminated because of computers, but the demand for preparing data for computer analysis will be great. Many bank tellers, who wrote entries by hand, are now using computer terminals to record transactions. And the demand for such employees is likely to continue to grow.

Finally, the nature of work performed by medical laboratory personnel is expected to shift because of automation. Fewer medical technologists will be required because more medical technicians and assistants, who require less formal training than the technologists, will use automated test equipment. This equipment is performing tasks formerly requiring the medical technologists' expertise.

Other occupations may also be affected by automation

Statements made by members of the private sector of the economy (unions, academia, computer manufacturers, and others) show that other occupations, in addition to those BLS adoresses in its handbook, may also be affected by automation. These include assemblers, inspectors, library assistants, machinists, mail carriers, mechanics, middle managers, teachers, telephone and television repairers, and warehouse drivers.

Coverage provided in the "Occupational Outlook Handbook" is being reduced

BLS said that because of budget cuts, the scope of the "Occupational Outlook Handbook" is being reduced. Most information about major industries contained in the 1980-81 edition is to be eliminated and the number of occupations to be covered by the handbook is being reduced. The next edition of the handbook is due to be released in the spring of 1982.

CHAPTER 4

THE IMPACT OF AUTOMATION ON EMPLOYMENT IS THE SUBJECT OF CONSIDERABLE DEBATE

Over the years, the question of whether automation will cause a long-run increase in overall U.S. unemployment has been debated considerably. Much of this debate started in the late 1950s and early 1960s when computer technology was first introduced on a widespread basis. The debate was serious enough and unemployment high enough to cause the Congress to establish a commission to study the subject. The commission concluded, in 1966, that automation would not cause severe unemployment in the next decade, and in fact it did not. Actually, the unemployment rate decreased.

Although massive, computer-related unemployment did not occur in the 1960s and 1970s, concern over unemployment was renewed in the mid-1970s when the advent of microelectronic computers stimulated the use of automation more than ever before.

The concern is not unique to the United States. In 1978 the British Broadcasting System broadcast a program entitled "The Chips Are Down," and in 1980 the Worldwatch Institute issued a document entitled "Microelectronics at Work: Productivity and Jobs in the World Economy." These and other more recent sources have forecasted massive unemployment due to the introduction of automation.

Nearly everyone expressing an opinion on this subject agrees that some jobs will be lost in the short run because of automation. This displacement can have a two-fold effect: (1) people will lose their existing jobs and (2) people entering the work force will not be able to find jobs in their chosen field. In both cases, unemployment exists for some undetermined period of time.

Although that belief has found support in studies of automation's impact on individual occupations and in examples from various segments of the economy, we found wide differences of opinion about the long-run impact of automation on overall U.S. unemployment.

Some say overall employment will grow because of the advancing technology, while others say overall employment will decrease as a direct result of automation.

OPINIONS ABOUT AUTOMATION'S IMPACT ON EMPLOYMENT VARY WIDELY

People taking the position that automation will result in long-run increased unemployment overall do not believe that jobs created by an expanding economy, or by automation itself, will equal jobs lost through automation. Others argue that although the number of jobs may increase, the increase will not keep pace with the growth in the labor force.

There is a school of thought in the United States, however, that believes automation will actually foster increased employment overall. Advocates argue that:

--Increased foreign competition has reduced the share of the U.S. market for certain industries, and has thus caused unemployment. Increased productivity fostered by automation will help stabilize or lower prices so that these industries can regain their share of the market, or even increase it, and therefore create the need for some jobs already lost.

--New occupations and jobs directly created by automation will equal or exceed the jobs lost through displacement. A case in point is the computer industry itself where there is a growing shortage of people to fill computer software positions such as programmers, systems designers, and analysts. Some other occupations that are growing because of the increased use of automation are described in appendix II.

--The continued growth of the economy, which automation will help foster, will in itself create more jobs. Growth, as reflected by an expanding economy and the demand for more goods and services, means more jobs.

--Automation could benefit competition within the U.S. domestic market by preventing certain companies from ceasing operations or going bankrupt.

--While jobs will be eliminated in the short run, the main impact of automation will be a change in the types of jobs to be done and in what people must do to perform them. We cited examples of this in chapter 3.

MANY UNKNOWNS CAUSE THE DIFFERENCES IN OPINION ABOUT AUTOMATION'S LONG-RUN IMPACT

Evidence from various sources shows that automation causes short-run displacement. These sources include (1) BLS comments on and projections for certain occupations (see app. I), (2) a private study made on three occupations affected by automation--printers, supermarket cashiers, and telephone operators, and (3) statements made by trade union officials. Other sources such as computer manufacturers, trade associations, and other Federal agencies, also recognize that at least isolated pockets of job displacement occur; that is, certain occupations are hard hit.

The debate arises, however, over whether long-run unemployment will increase in the general economy or more jobs will be created overall. The differences in opinion on the long-run impact on unemployment seem to be centered on several factors that can ultimately affect predicting the outcome. These factors include:

--How rapidly the new technology (microelectronics and other advances in automation) is going to be implemented and whether institutional and other barriers to rapid implementation will exist.

--The complexity of the unemployment issue; many variables affect unemployment levels.

--An absence of specific data on the net change in unemployment because of automation.

These factors, discussed in this chapter, have resulted in different positions on the issue. Without specific hard data, and considering the complexities of the issue, a definite conclusion cannot be reached. The probability of increased long-run unemployment caused by automation is therefore unknown.

The speed of implementing the new technology has a bearing on unemployment

The advancement of electronic automation is sometimes referred to as the "computer revolution" because of its impact in the 30 years since the first large-scale, electronic computer was introduced. As was the case with the agricultural and industrial "revolutions," potential barriers or constraints may slow the actual implementation of automated technologies. This could slow its impact on employment and actually make automation's implementation in the long run evolutionary. Constraints on the rapid implementation of automated applications would allow time for adjustments to reduce the impact and allow for necessary job shifts through training and retraining. Rapid implementation of automated technologies would be more apt to result in increased unemployment, at least temporarily.

Some of the constraints cited by experts are institutional, financial, historical, and independent of the technology; others are peculiar to the technology itself. They include union actions to protect workers, human and institutional resistance to change, capital investment considerations, software costs and problems, system development and debugging problems, difficulties in interfacing new equipment within existing operations, and a lack of qualified people needed in an automated environment.

For example, we were informed by a potential user of videodisc microelectronic devices and a current user of older automated technology for teaching purposes that one of the major problems in using automated teaching devices was getting the course material designed in the software. Literature also exists that discusses the high costs and shortages of capable people to prepare computer software. This is seen as a barrier to more rapid implementation of automation.

Human and institutional resistance to the implementation of automation, another barrier, can be demonstrated through consumer

resistance to automatic check-outs at supermarkets and electronic funds transfers. Consumer resistance in these particular applications is seen as one reason that their growth has been slowed. Also, some managers are resisting the use of office automation equipment.

Another example involves the reluctance of some commercial enterprises to invest in new capital equipment because of such considerations as cost recovery, investment in new, untried equipment, and retrofitting the automated equipment i to existing facilities and operations. But wage inflation is making the use of automation more economically rational.

The complexity of the unemployment issue makes it difficult to isolate the impact of automation

The rate of unemployment and the number of available jobs in the United States are highly complex issues. Many forces affect both issues, often at the same time. Therefore, it is difficult to isolate the impact of automation alone on employment.

A major influence, of course, is the movement of the overall economy as affected by inflation, recessions, productivity, and other related factors. But other more specific and often related factors affect U.S. employment on an overall, industrywide, or occupational basis.

Some of the other factors that influence both the demand for jobs and unemployment levels include

--foreign competition, including imports of less expensive, and/or better quality products into the United States;

--technological innovations other than automation;

--changes in consumer preferences for goods and services;

--business bankruptcies;

--fiscal, monetary, and socioeconomic policies of the Federal Government, for example, the availability of money, tax policies, and Government spending;

--policies of foreign entities, for example business purchases, embargoes, and import taxes;

--energy-related matters;

--the balance between labor supply and skill demand; and

--growth in population and personal incomes (demand for goods and services).

The automobile industry is a good example of how imports of competitive consumer goods that are cheaper and/or of superior quality can have a major impact on U.S. employment. Increases in automobile imports have reduced the share of the domestic market held by U.S. automobile producers, and as a result, the work force in U.S. automobile plants has been severely reduced. The introduction of automation to increase productivity and lower prices can actually serve to increase employment to a certain degree by increasing the market share. Other foreign products affecting the employment levels in the United States include clothing and textiles, shoes, rubber, and steel.

The development and use of other technologies unrelated to automation is another example of a strong influence on U.S. employment levels. For instance, greater use of concrete as a building material in constructing apartments, highways, offices, and factories will add to the demand for cement masons. On the other hand, new electronic switching equipment is being manufactured in modules, which will greatly reduce the demand for central office equipment installers in offices of telephone companies. Technological developments related to energy and pollution control affect employment requirements in several occupations such as plasterers, plumbers, and pipefitters, as well as civil and mechanical engineers.

Changes in consumer demands, by affecting what and how goods are produced and which services are provided also have an effect on employment levels. Consumer-related changes have affected employment in transportation industries; for example, airplane travel has taken precedence over rail. The use of bank credit cards instead of department store credit has reduced the need for credit managers. And changes in hair styling--for example, in the 1970s, the popularity of longer hair styles--had an impact on the number and training of barbers.

Lack of specific and comprehensive data about the net impact of automation makes it impossible to arrive at a valid conclusion

We could not find comprehensive data specifically identifying the number of jobs eliminated, changed, created, or increased as a result of increased automation. Data collected from employers and employees by or for BLS for use in its econometric model does not comprehensively and specifically show this impact. Most of the contacts we made, as well as studies, articles, and other data reviewed, also revealed this lack of data.

Where data is presented, it includes only estimates or projections that may have been made within a given company, locality, plant, or occupation. Estimates are often based on gross changes in employment without adjustments for other previously described factors that affect employment levels.

No data or studies obtained show the possible multiple impacts of automation. An application may reduce employment in one industry or occupation but increase employment in others. We found no studies containing data showing the full realm of changes that occur in multi-industry or multi-occupation situations.

CHAPTER 5

LITTLE IS KNOWN ABOUT THE WORKER DISPLACED BY AUTOMATION

We are aware of no recently performed comprehensive studies identifying the characteristics of persons displaced by automation and their success in returning to the work force in meaningful employment. Nor could we find data about problems encountered by persons first entering the work force who had been trained in fields in which automation has reduced job opportunities.

We have made some observations about such persons and their problems by using more limited information obtained from BLS, academia, labor unions, and other available sources. These observations deal with the worker displaced, income levels and age when displacement is likely to occur, and private and governmental mechanisms available to assist them. One private study discussed some barriers preventing displaced New York printers from obtaining training and other assistance in preparing for reemployment in occupations of similar challenge and income.

ONLY LIMITED INFORMATION EXISTS ABOUT THE FATE OF WORKERS DISPLACED BY AUTOMATION

Information obtained shows that persons employed in the printing, automobile, railroad, communications, and other industries have lost jobs, due partly to automation. Most people we contacted knew little about the characteristics and earnings of workers displaced by automation and what eventually happens to them.

A recognized authority in the field headed two studies of displaced New York typesetters. The first study shows that in New York City, about 1,000 typesetters lost jobs in the late 1970s. Of these, more than 600 were left to find jobs in other fields; the rest retired. The objective of the followup study was to identify problems encountered by typesetters whose jobs were eliminated by computerized typesetting equipment. One of the several areas addressed was training offered to unemployed persons under Title II of the Comprehensive Employment and Training Act (CETA) of 1973.

Based on contacts with 44 unemployed typesetters, the authors concluded that primary Federal training for the unemployed, Title II of CETA, was inadequate for typesetters because:

--Earnings criteria for much of the CETA program made it unavailable to the higher paid skilled worker supporting a family (typesetters can earn $20,000 or more a year).

--Suitable training programs for typesetters displaced by automation were lacking. Many were formerly in high to middle income ranges while much federally sponsored training is for entry-level, low paying occupations.

--Only a small portion, less than 1 percent, of total CETA Title II money has been spent for retraining people laid off as a result of technological displacement. The primary thrust of CETA was for the disadvantaged and chronically unemployed.

--Economic assistance available to a displaced person wishing to undergo retraining is insufficient to maintain a household while attending classes.

Since that study was performed, funds for the overall CETA program have been reduced. Since fiscal 1980, reductions of more than 50 percent have been made, reducing the program from about $8 billion in fiscal 1980 to about $3 billion in fiscal 1982. Title II has also been reduced significantly, and further reductions for fiscal 1983 are currently planned.

The authors of the study do not consider other available mechanisms designed to assist the unemployed to be adequate for assisting displaced typesetters. 1/ These mechanisms are discussed later in this chapter. Many typesetters did not return to work or were employed in menial jobs. Since they were not retained, they did not receive the benefit of the training offered by the manufacturers of the automated devices. Many were unable or reluctant to take advantage of existing retraining (public and private) because of such factors as age, lack of mobility, and financial considerations.

No other recent studies about how automation affects displaced people were disclosed during our study, but an official of the National Science Foundation believes that a study of ergonomics (the relationship between people and machines) would be a worthwhile effort.

AVAILABLE INFORMATION SUGGESTS THAT DISPLACEMENT CAUSED BY AUTOMATION MAY AFFECT A WIDE RANGE OF PEOPLE

Some of the literature on the subject of automation and unemployment addresses the kinds of job skills that will be reduced or eliminated. Some opinion exists that automation will eliminate the monotonous, routine, dirty, and dangerous jobs that people should not perform. These jobs are often looked at as relatively low paid and unskilled and are better performed by machines than people. These kinds of jobs can be found in many industries.

However, other people recognize that the computer and other forms of automation can also be applied to functions that are performed by persons with higher level skills who receive more

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1/The authors performed a similar study of typesetters displaced in the Washington, D.C., area. That study, which was completed in January 1982, disclosed similar problems.

pay. Some literature discusses the replacement of middle level management with computer applications that can make decisions with little or no human intervention based on input data and decision-making criteria contained in the computer programs. These applications, which we referred to in a report we issued in 1976 1/ as "automated decisionmaking," are seen by some to be an extension of computer decisions to higher level management decisionmaking. This school of thought sees the polarization of skills, with a virtual elimination of mid-level skills--only the unskilled and the highly skilled would be demanded.

Income levels of displaced workers vary greatly

The income levels in the 33 occupations identified by BLS as being adversely affected by automation vary significantly; from below $10,000 to as much as $40,000 or more a year. (See app. I.) Salaries of affected industrial trade occupations, such as production painters, motion picture projectionists, and tool-and-die makers, can earn from below $10,000 to as high as $26,000 or more. Office occupations affected by automation are filled by persons earning from under $10,000 as file clerks and bookkeeping workers to persons earning $40,000 or more as credit managers and insurance agents and brokers.

Other occupations discussed by sources independent of BLS include middle managers, teachers, and supermarket check-out cashiers. Again, the range of income is wide--cashiers can make under $10,000 while middle managers may be paid from $25,000 to $50,000 and up. Teacher salaries generally fall between these ranges.

Ages of displaced worker also vary greatly

The nature of the affected occupations and the protections afforded certain workers through union contracts--for example, layoffs determined via seniority--show that the age levels of the displaced worker can vary as greatly as income levels. Examples of what we know about the age levels of the displaced worker follow.

Printing occupations

Because of the adaptability of this industry to automation, printing occupations are considered "hard hit" by automation, resulting in the displacement of persons at the height of their careers (age 40 and up). Even union contract clauses providing liberal severance pay have not been able to significantly reduce the impact of displacement on this age group. Younger persons

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1/"Improvements Needed In Managing Automated Decisionmaking by Computers Throughout the Federal Government" (FGMSD-76-5, Apr. 23, 1976).

attempting to enter the industry may also be affected by the lack of available jobs.

Supermarket cashiers and telephone operators

These occupations are generally held by men and women who regularly move in and out of the job market and often shift careers. Many are part time. The age of persons in these occupations, and in those of a similar nature, will vary greatly.

Postal workers

Union-management contract clauses are designed to protect the jobs of employees, thus shifting most of the displacement to the person who might be seeking a postal worker job. Although this could affect persons of any age, it would likely affect the younger individual the greatest. The number of postal workers has been declining over the past 10 years because of automation, but the decline has been achieved almost entirely through attrition.

Skills affected vary significantly

An examination of the qualifications required for the various occupations that, according to BLS, are being adversely affected by automation shows that a wide range of skills, from the unskilled to the highly skilled, are involved. Positions such as stock clerks, file clerks, and cashiers require very little if any specialized training--all such occupations can be learned through on-the-job training. Occupations such as tool-and-die makers, printing compositors, drafters, and credit managers are more skilled and require specific classroom and/or formal on-the-job training.

MECHANISMS TO ASSIST THE DISPLACED WORKER ARE AVAILABLE FROM PRIVATE AND GOVERNMENT SOURCES

Our study identified some existing private and public mechanisms that are available to assist some workers displaced by automation or threatened by such displacement. The remainder of this chapter briefly describes many of those mechanisms.

Private mechanisms involve union and management agreements and training offered by computer manufacturers

Efforts of labor unions in contract negotiations with management as well as training offered by computer manufacturers are geared primarily toward existing employees. Many of the unions we contacted described what they attempt to do to afford member protection. Some of the mechanisms are often, but not always, used to ease the impact of displacement on workers, but union contracts vary and not all of them contain these provisions.

Reductions in work force through attrition

Several unions advised us that they attempt to make the work force reductions required by management through attrition. Where attrition is the rule, no one is laid off if possible. Instead, reductions are made by not replacing people who retire, die, or move to other jobs.

Guaranteed employment

At least one union has been successful in establishing a limited guaranteed employment clause. This clause guarantees that current job holders meeting certain requirements will retain their position for life, as long as the company stays in business.

Use of seniority rights in determining layoffs

Most unions contacted require management to lay off persons that have the least time invested in the occupation, company, and/or union. In essence, the longer a person has been employed, the less chance he or she will have of being displaced. Seniority clauses do not prevent layoffs, however.

Retraining clauses

Some union contracts contain clauses requiring management to provide some kind of training or retraining to employees it wishes either to move to other existing or newly created occupations in the company or lay off. Retraining clauses, for the most part, are less likely to be contained in negotiated contracts compared to some of the previous mechanisms discussed in this chapter, but some opinion exists that they will be needed in future contracts.

Computer manufacturers have advised us that they offer training courses, which are often free of charge, to acquaint employees with how to use the new equipment. This training, however, appears to be only for those employees who are expected to be retained by the employer.

Technology committees and advanced notices

One union contacted has been successful in negotiating clauses in contracts that require management to provide notice in advance of the implementation of new technological innovations. This type of clause allows employees the opportunity to prepare for potential displacements that may occur as a result of the new technology.

Severance pay

Many unions have negotiated a severance pay clause in their contracts with management. Severance pay could be used by the displaced worker to look and/or train for another job. We noted

one union contract that contains a 2-year severance pay clause and another containing one for up to 103 weeks.

Federal, State, and local government assistance to the unemployed worker

No specific public assistance is provided to those workers displaced by automation. Instead, benefits to the unemployed in general are provided. These benefits include federally funded training under CETA, other available federally sponsored training, job placement services, unemployment insurance, and welfare.

CETA training

CETA Title II training involves classroom and on-the-job training, short-term and part-time work experience assignments, and other job-related services.

The prime target for CETA Title II training is the disadvantaged and the chronically unemployed. Only a very small portion (less than 1 percent in fiscal 1980) is made available for retraining and upgrading persons displaced for such reasons as automation. Based on the goals established under Title II of the act, almost all occupations that CETA training covers are entry level and low paying.

Other federally sponsored training

At the cabinet level is the Department of Education which establishes policy and administers and coordinates most Federal assistance to educational institutions. The Department of Defense provides training to military recruits in specific areas of administration, automatic data processing, communications operations and repair, law enforcement, medical and X-ray specialists, supply management, transportation career activities, and others. Many other agencies support or provide training in other specific career activities.

The public employment service system

The Department of Labor apportions funds and provides guidance and technical assistance to the public employment service system which in fiscal 1981 operated 2,500 local offices in the United States and its territories. The offices are operated by State governments and are tasked with providing assistance for all job seekers and employers who ask for it. Using matching procedures, employment counselors, aptitude testing, and other mechanisms, the service is responsible for referring people to jobs for which they are best qualified. According to the Department of Labor, 3.7 million persons were placed in jobs in fiscal 1981.

Unemployment insurance

The unemployment insurance program, financed by Federal and State payroll taxes, pays benefits for up to 26 weeks in most States, with limited extended benefits during periods of high unemployment. Maximum benefits vary by State, but most States pay at a rate of less than $7,500 a year. The amount paid depends on past wages and is subject to minimum and maximum levels set by the States.

Welfare

The Social Security Administration is responsible for administering the income maintenance portion of grants to States under Title IV, the Aid to Families with Dependent Children portion of the Social Security Act. Eligibility requirements adopted by the majority of States include provisions involving the unemployment of a parent, and payments are made, in part, based on those as well as many other provisions. Federal, State, and sometimes local funds are provided for these payments, and maximum levels are set by several States.

Monthly payments under this program in no way match the income made by persons employed in well paying jobs. Many consider welfare a poor substitute for gainful employment.

Other public benefits

Other benefits under CETA and other Federal programs exist. Most often designed for a specific group of persons, they include various forms of aid to Native Americans, migrant workers, the disabled, and other special groups. But generally these are not benefits that would apply to U.S. workers displaced by automation.

Federal budget cuts are being made

While we were completing this staff study, Federal funding for several of the public assistance mechanisms just discussed was reduced, and more reductions are contemplated.

CHAPTER 6

SUMMARY OF OBSERVATIONS

Assessing the long-run impact of automation on overall unemployment levels is complicated by the fact that comprehensive data on displacement caused by automation is generally lacking and unemployment levels are affected by a number of complex factors--some known, some unknown. Nevertheless, the data that is available supports the following observations:

--The use of automation to increase productivity is growing and is becoming a pervasive force in more and more industries, occupations, and jobs. Unlike some technological innovations, automation has the potential to affect a great many industries and occupations. It creates new occupations, increases jobs in some occupations, decreases them in others, and changes the nature of jobs in still others.

--The long-run impact of automation on overall unemployment levels is not really known. Many people have an opinion. Some argue that unemployment will be increased, others argue it will decrease. The Department of Labor believes that the number of jobs will grow and unemployment will decrease. Opinions vary partly because of different assumptions made about economic, social, political, and international factors which also affect unemployment levels.

--The speed with which automation is implemented also affects unemployment. From an overall perspective, many believe that the adoption of automation and its attendant impact on employment to date have been more evolutionary than revolutionary. However, some believe that the rate of change may quicken and a long-run increase in overall unemployment is possible. But the probability of this is not known because the complexities and unknowns surrounding this issue are great.

--While the magnitude of automation's impact on long-run unemployment is really not known, it has caused some short-run job displacements over the years. Some believe that automation's greatest impact is on relatively low paying, hazardous occupations. However, evidence suggests that higher paying occupations are also being affected and will continue to be in the future.

The thrust of this study was to bring about a public and private awareness of the issues as well as the differences of opinions that exist and the reasons for them. Because of the potential for significant change, events in this area should continue to be watched closely by the many components of the U.S. economy (business, labor, government, and education). If a noticeable trend toward increased occupational impact occurs, existing mechanisms for assisting the unemployed may need to be reassessed.

BLS DATA ON 33 OCCUPATIONS ADVERSELY AFFECTED BY THE USE OF COMPUTERS OR OTHER AUTOMATION (note a)

Occupation	1978 employment level	Percentage change projected to 1990 (decline)	How computers or automation affect employment	Salary level (note b)
Industrial:				
1. Molders	21,000	5	Increased use of automatic machine molding, e.g., the sand slinging process will moderate the growth of employment of molders.	An average of $5.90 to $6.20 an hour ($12,270 to $12,900 a year)
2. Machine tool operators	542,000	12	Faster and more versatile automatic machine tools will limit employment growth of operators.	An average of $6.27 to $9.35 an hour ($13,040 to $19,450 a year)
3. Machine set-up workers	65,000	24	Automatically controlled machine tools may limit need for additional workers.	$8.00 an hour on the average ($16,640 a year)
4. Tool-and-die makers	170,000	24	Growth may be limited by the use of numerically controlled machines that have significantly changed toolmaking processes.	An average of $7.19 to $10.53 an hour ($14,955 to $21,900 a year)
5. Printing compositors	181,000	(13)	Decline expected because of trend toward high speed phototypesetting and typesetting computers.	An average of $9.00 to $9.49 an hour ($18,720 to $19,740 a year)
6. Photoengravers	8,000	(6)	Trend toward automated platemaking, offset printing, and color scanners and enlargers should reduce the need for photoengravers.	A minimum of $9.63 an hour on the average ($20,030 a year)
7. Electrotypers and stereotypers	2,000	Decline (note c)	Employment is expected to decline because of labor-saving devices, such as automatic plate casting and offset printing.	A minimum of $8.14 to $9.17 an hour ($16,930 to $19,075 a year) on the average
8. Boiler-tenders	71,000	No growth	Little change because new boilers are equipped with automatic controls.	An average of $4.00 to $8.42 an hour ($8,320 to $17,515 a year)
9. Electroplaters	40,000	No growth	Employment growth will be restricted by increasing use of automated plating equipment.	$3.75 to $8.00 an hour ($7,800 to $16,640 a year)

APPENDIX I

Occupation	1978 employment level	Percentage change projected to 1990 (decline)	How computers or automation affect employment	Salary level (note b)
10. Motion picture projectionists	11,000	No growth	Employment will not keep pace because of various factors, including automated projection machines.	An average of $5.00 to $12.50 an hour ($10,400 to $26,000 a year)
11. Photographic laboratory occupations	57,000	20	Will not grow as fast as demand for film processing partly because of increasing automation of photo lab operations.	$2.90 to $8.00 an hour ($6,030 to $16,640 a year)
12. Production painters	133,000	19	Will not grow as fast as manufacturing output because of automatic painting processes.	$3.42 to $10.50 an hour ($7,115 to $21,840 a year)
Office:				
13. Bookkeeping workers	1,830,000	12	Future employment growth will be slowed by the increasing use of computers.	$7,400 to $14,800 a year
14. Cashiers	1,400,000	50	Employment of cashiers is likely to be affected by computerized checkout systems.	$2.65 to $7.64 an hour ($5,510 to $15,890 a year)
15. File clerks	273,000	23	Growth will be slower than the past, reflecting more extensive use of computers to arrange, store, and transmit information.	$126 to $194 a week ($6,550 to $10,090 a year)
16. Hotel front office clerks	79,000	24	Employment growth will be limited by the use of computerized front office systems.	Not presented by BLS
17. Office machine operators	160,000	5 to 15	Demand for additional workers will be restrained because of continued advances in office technology and computerized recordkeeping.	$167 to $195 a week ($8,685 to $10,140 a year)
18. Postal clerks	260,000	(19)	Employment will decline because of more efficient automated sorting and electronic mail.	$14,600 to $17,200 a year
19. Shipping and receiving clerks	461,000	23	Employment will continue to be affected by computers used to store and retrieve shipping and receiving records.	An average of $227 to $280 a week ($11,805 to $14,560 a year)
20. Stock clerks	507,000	18	Employment will continue to be affected by computers used for inventory control and automated equipment to move stock.	An average of $143 to $226 a week ($7,435 to $11,750 a year)
21. Insurance claim representatives	169,000	41	Slower growth for life insurance examiners because increased use of computers enables processing of more claims.	$11,200 to $18,600 a year on the average

APPENDIX I

Occupation	1978 employment level	Percentage change projected to 1990 (decline)	How computers or automation affect employment	Salary level (note b)
22. Insurance agents, brokers	540,000	20	Employment will not keep pace with sales because computers will take over some of the time-consuming clerical tasks.	$10,800 to $40,000 a year or more
23. Buyers	115,000	24	Increased use of computerized systems to maintain inventories and to order standard items of merchandise will slow growth.	$23,000 to $32,000 a year or more
24. Credit managers	49,000	14	Despite consumer debt increases, computers used for storing and retrieving information will enable efficient processing of greater volumes of information.	An average of $11,0 to $40,000 a year
Service:				
25. Telephone operators	311,000	(7)	Technological improvements, such as electronic switching and traffic service position systems resulting in computer billing, will limit employment.	$4.31 to $10.20 an hour ($8,965 to $21,215 a year)
Transportation:				
26. Brake operators (railroad)	66,000	No growth	The number of yard brake operators will decrease because of automatic classification systems installed in more yards. These systems electronically route cars to the proper track.	An average of $1,300 to $1,800 a month ($15,600 to $21,600 a year)
27. Railroad conductors	37,000	6	Employment of yard conductors will not grow because of the addition of automatic classification systems.	An average of $1,600 to $2,100 a month ($19,200 to $25,200 a year)
28. Locomotive engineers	34,000	10	Employment of yard engineers is not expected to change because of the addition of automatic classification systems.	An average of $1,800 to $2,300 a month ($21,600 to $27,600 a year)
29. Telegraphers, telephoners, and tower operators (railroad)	10,000	(30)	Employment will decline because of centralized traffic control and other automatic signaling and control systems to direct train traffic.	$7.34 an hour on the average ($15,265 a year)
Scientific and Technical:				
30. Broadcast technicians	40,000	15 to 25	Labor-saving technical advances, such as automatic programming will hold down demand for additional technicians.	$140 a week and up ($7,280 a year and up)
31. Drafters	296,000	24	Expanding use of electronic drafting equipment and computers will reduce the need for less skilled drafters.	$9,800 to $16,900 a year

APPENDIX I

Occupation	1978 employment level	Percentage change projected to 1990 (decline)	How computers or automation affect employment	Salary level (note b)
Mechanics and Repairers:				
32. Central office telephone craft occupations	135,000	(4)	Electronic switching systems and electronic self-diagnostic test equipment will reduce employment.	$4.96 to $9.18 an hour ($10,315 to $19,095 a year)
33. Radio and television announcers	27,000	22	Employment is not expected to keep pace with an increased number of stations because automatic programming equipment will be used.	$150 a week and up ($7,800 a year to start)

SUMMARY:

	Occupations adversely affected by automation	1978 employment level
Occupations expected to decline due, in part, to automation	7	907,000
Occupations not growing because of automation's adverse effect	4	188,000
Number of occupations expected to grow despite automation	22	7,905,000
Total	33	8,100,000

a/Data taken from BLS' "Occupational Outlook Handbook," 1980-81 edition.

b/These figures represent 1978 earnings data which are shown in the 1980-81 handbook. Earnings across industry lines have increased by 27 percent through 1981, on the average, for all industries, excluding agricultural and supervisory occupations. This should be considered when examining the salary levels presented. Hourly, weekly, and monthly earnings are converted to annual salaries based on a 40-hour week with no overtime.

c/BLS made no estimate of the percentage decline for electrotypers and stereotypers.

APPENDIX I

BLS DATA ON
26 OCCUPATIONS INCREASING IN NUMBER
PARTLY BECAUSE OF COMPUTERS OR OTHER AUTOMATION (note a)

Occupation	1978 employment level	Percentage change projected to 1990	How computers or automation affect employment	Salary level (note b)
Industrial:				
1. Instrument makers (mechanical)	6,000	17	Workers will be needed to make custom or special instruments in expanding field of industrial automation.	Generally more than $8.00 an hour on the average ($16,640 a year)
Office:				
2. Computer operating personnel (excluding keypunch)	400,000	15 to 25	Miniaturizing circuits will expand the use of computers because of size and cost reduction.	An average of $175 to $300 a week ($9,100 to $15,600 a year)
3. Computer programmers	247,000	30	Employment will grow as computer use increases.	An average of $200 to $465 a week ($10,400 to $24,180 a year)
4. Systems analysts	182,000	37	Employment will grow as computer use increases.	$200 to $460 a week ($10,400 to $23,290 a year)
5. Bank clerks	505,000	50	Job opportunities will be good especially for persons trained to operate peripheral computer equipment.	$110 to $135 a week to start ($5,720 to $7,020 a year)
6. Bank officers and managers	330,000	55	Increasing dependence on computers will require more officers to provide sound management and quality control.	$900 to $1,600 a month to start ($10,800 to $19,200 a year and up)
7. Accountants	985,000	29	Increasing use of computers in accounting should stimulate demand for accountants trained in such procedures.	An average of $13,500 to start to $40,000 a year
8. City managers	3,000	52	Employment will grow as government management becomes more complex, as reflected by computerized tax and utility billing, electronic traffic control, etc.	$12,000 to more than $50,000 a year
Service:				
9. State police	47,000	26	Specialists will be needed in electronic data processing centers to develop administrative and criminal information systems.	An average of $13,200 to start to $22,100 a year

APPENDIX II

Occupation	1978 employment level	Percentage change projected to 1990	How computers or automation affect employment	Salary level (note b)
Education:				
10. Librarians	142,000	13	Expanding use of computers to store information and handle routine operations (cataloging and ordering) will sustain the need for information and automation specialists.	$10,900 to over $38,700 a year
Scientific and Technical:				
11. Ceramic engineers	14,000	27	Programs related to electronics, e.g., integrated circuits, will provide job opportunities.	$13,700 to over $30,500 a year
12. Chemical engineers	53,000	20	Growing automation of chemical processes will require more chemical engineers to design, build and maintain the necessary plants and equipment.	$13,700 to over $30,500 a year
13. Electrical engineers	300,000	22	Demand for computers, communications, etc., is expected to be a major contributor to growth as electrical engineers design, develop, test, and supervise their manufacture.	$13,700 to over $30,500 a year
14. Industrial engineers	185,000	26	Expansion of computer and automated processes contributes to employment growth as industrial engineers solve organizational, production, and related problems.	$13,700 to over $30,500 a year
15. Metallurgical engineers	17,000	29	Computers require lightweight metals of high purity resulting in need to (1) develop new ways of recycling and (2) solve unprofitable mining situations.	$13,700 to over $30,500 a year
16. Mathematicians	33,000	10	Mathematicians are likely to find openings as computer programmers and systems analysts in industry and government.	$10,500 to start to over $25,900 a year
17. Physicists	44,000	9	Demand for physicists in electronics industry will be good because of expanding research in computer technology.	$12,900 to over $30,200 a year
18. Engineering and science technicians	600,000	25	Automation of industrial processes adds to the demand for technical personnel to develop, manufacture, and service equipment and systems.	$9,000 to over $19,600 a year
Mechanics and Repairers:				
19. Business machine repairers	63,000	56	Use of electronic devices, e.g., electronic cash registers, will provide favorable opportunity for repairers with training in electronics.	$150 to over $300 a week ($7,800 to over $15,600 a year)

APPENDIX II

Occupation	1978 employment level	Percentage change projected to 1990	How computers or automation affect employment	Salary level (note b)
20. Computer service technicians	63,000	93	More computer equipment will be used and many more technicians will be needed for installation and maintenance.	An average of $220 to start to $400 a week and up ($11,440 to $20,800 a year)
21. Maintenance electricians	300,000	28	Growth of maintenance electricians will stem from increased use of electronics equipment by industry.	$3.60 to $9.35 an hour ($7,490 to $19,450 a year)
Health:				
22. Medical record administrators	13,000	20	Growing use of computers for medical information should increase the demand for administrators to develop new medical information systems.	$10,500 to well over $30,000 a year
Social Scientists: (note c)				
23. Economists	130,000	39	Economists with strong backgrounds in computer sciences are needed for marketing research.	$10,500 to over $33,000 a year
24. Political scientists	14,000	14	A strong background in computer sciences increases the chances for a job in business, industry, or consulting firms.	An average of $10,300 to start to over $32,900 a year
25. Sociologists	19,000	8	As sociologists apply computer techniques in their research, those trained in computer sciences will be among those with the widest choice of jobs.	An average of $10,700 to start to over $32,900 a year
Communication:				
26. Technical writers	24,000	15 to 25	Those with backgrounds in computer sciences electronics will be in demand.	$8,000 to $25,000 a year, or more
Total	4,719,000			

a/Data taken from BLS "Occupational Outlook Handbook," 1980-81 edition.

b/These figures represent 1978 earnings data which are shown in the 1980-81 handbook. Earnings across industry lines have increased by 27 percent through 1981, on the average, for all industries, excluding agricultural and supervisory occupations. This should be considered when examining the salary levels presented. Hourly, weekly, and monthly earnings are converted to annual salaries based on a 40-hour week with no overtime.

c/Automation in itself may not be a major cause for the increased demand for these occupations. However, demand will be shifted to those persons with computer backgrounds because of increased uses of computers.

APPENDIX II

ORGANIZATIONS CONTACTED

Nature of organization	Name of organization
Federal agencies	Department of Commerce
	Department of Defense
	Department of Education
	Department of Labor
	National Science Foundation
	Office of Technology Assessment
Computer manufacturers	International Business Machines Corporation
	Texas Instruments Incorporated
	Wang Laboratories Inc.
Trade unions	Amalgamated Clothing and Textile Workers Union
	American Federation of Labor and Congress of Industrial Organizations
	American Postal Workers Union
	Brotherhood of Railway, Airline, and Steamship Clerks, Freight Handlers, Express and Station Employees
	Communications Workers of America
	International Brotherhood of Electrical Workers
	International Ladies Garment Workers Union
	International Union of Electrical, Radio, and Machine Workers
	International Union, United Automobile Aerospace and Agricultural Implement Workers of America - UAW
	National Education Association
	Oil, Chemical and Atomic Workers International Union
	Service Employees International Union
	Transport Workers Union of America
	United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada
	United Food and Commercial Workers International
	United Paperworkers International Union
Trade associations	American Bankers Assocation
	American Society of Association Executives
	Association of American Railroads
	National Association of Manufacturers

APPENDIX III

Nature of organization	Name of organization
Educational institutions (members)	Columbia University (Director, Computing Activities)
	Massachusetts Institute for Technology, Sloan School of Management (Assistant Professor of Management)
	New Jersey Institute of Technology (Professor of Computer and Information Science)
	School District of Philadelphia (Director, Division of Instructional Systems)
	University of Pennsylvania, Wharton School (Assistant Professor of Decision Sciences)
Other private organizations	Allen Landsburg Productions
	Newsweek Broadcasting Service
	The Charles Stark Draper Laboratory, Inc.

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